INTELLIGENT ARCHITECTURES FOR SUSTAINABLE HOUSING: USE OF AI IN THE MANAGEMENT AND STORAGE OF RENEWABLE ENERGY

ARQUITETURAS INTELIGENTES PARA HABITAÇÕES SUSTENTÁVEIS: USO DE IA NA GESTÃO E ARMAZENAMENTO DE ENERGIA RENOVÁVEL

ARQUITECTURAS INTELIGENTES PARA VIVIENDAS SOSTENIBLES: USO DE IA EN LA GESTIÓN Y ALMACENAMIENTO DE ENERGÍA RENOVABLE

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ABSTRACT
The growing integration between digital technologies and renewable energy sources has redefined how energy consumption is organized in residential environments, especially in the context of sustainable housing. The present study aims to analyze how intelligent architectures based on artificial intelligence can optimize the management and storage of renewable energy in sustainable housing, aiming at greater energy efficiency and residential autonomy. Regarding the research design, a qualitative approach was adopted, guided by the interpretative analysis

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of data from multiple sources. This methodological choice allows for examining the investigated phenomenon in greater detail, considering not only the data itself but also the contexts in which they are embedded and the meanings associated with the analyzed technologies. By articulating theoretical and documentary information, it becomes possible to develop a consistent analysis capable of integrating different perspectives and expanding the understanding of the topic in a more comprehensive and contextualized manner. In summary, the research demonstrated that the integration of intelligent architectures, artificial intelligence, and energy storage systems contributes to the development of more efficient and autonomous housing by enabling more precise and adaptive energy management. The articulation of these technologies promotes the rational use of renewable sources and fosters greater balance in residential energy consumption, consolidating a housing model aligned with current demands for efficiency and sustainability.

Keywords: Intelligent Architectures. Artificial Intelligence. Renewable Energy. Energy Efficiency.

RESUMO

A crescente integração entre tecnologias digitais e fontes de energia renovável tem redefinido o modo como o consumo energético é organizado em ambientes residenciais, especialmente no contexto das habitações sustentáveis. O presente estudo tem como objetivo geral analisar como arquiteturas inteligentes baseadas em inteligência artificial podem otimizar a gestão e o armazenamento de energia renovável em habitações sustentáveis, visando maior eficiência energética e autonomia residencial. No que se refere à condução da pesquisa, adotou-se uma abordagem qualitativa, orientada pela análise interpretativa de dados provenientes de múltiplas fontes. Essa escolha metodológica permite examinar o fenômeno investigado com maior nível de detalhe, considerando não apenas os dados em si, mas também os contextos em que estão inseridos e os significados associados às tecnologias analisadas. Ao articular informações de natureza teórica e documental, torna-se possível desenvolver uma análise consistente, capaz de integrar diferentes perspectivas e ampliar a compreensão do tema de forma mais abrangente e contextualizada. Em síntese, a pesquisa demonstrou que a integração entre arquiteturas inteligentes, inteligência artificial e sistemas de armazenamento de energia contribui para a construção de habitações mais eficientes e autônomas, ao permitir uma gestão energética mais precisa e adaptativa. A articulação entre essas tecnologias favorece o uso racional de fontes renováveis e promove maior equilíbrio no consumo energético residencial, consolidando um modelo de habitação alinhado às demandas atuais por eficiência e sustentabilidade.

Palavras-chave: Arquiteturas Inteligentes. Inteligência Artificial. Energia Renovável. Eficiência Energética.

RESUMEN

La creciente integración entre tecnologías digitales y fuentes de energía renovable ha redefinido la forma en que se organiza el consumo energético en entornos residenciales, especialmente en el contexto de viviendas sostenibles. El presente estudio tiene como objetivo analizar cómo las arquitecturas inteligentes basadas en inteligencia artificial pueden optimizar la gestión y el almacenamiento de energía renovable en viviendas sostenibles, con el fin de lograr una mayor eficiencia energética y autonomía residencial. En cuanto al desarrollo de la investigación, se adoptó un enfoque cualitativo, orientado por el análisis interpretativo de datos provenientes de múltiples fuentes. Esta elección metodológica permite examinar el fenómeno investigado con mayor nivel de detalle, considerando no solo los datos en sí, sino también los contextos en los que se insertan y los significados asociados a las tecnologías analizadas. Al articular información de carácter teórico y documental, se posibilita desarrollar un análisis consistente, capaz de integrar diferentes perspectivas y ampliar la comprensión del tema de manera más amplia y contextualizada. En síntesis, la investigación demostró que la integración entre arquitecturas inteligentes, inteligencia artificial y sistemas de almacenamiento de energía contribuye a la construcción de viviendas más eficientes y autónomas, al permitir una gestión energética más precisa y adaptativa. La articulación de estas tecnologías favorece el uso racional de fuentes renovables y promueve un mayor equilibrio en el consumo energético residencial, consolidando un modelo de vivienda alineado con las demandas actuales de eficiencia y sostenibilidad.

Palabras clave: Arquitecturas Inteligentes. Inteligencia Artificial. Energía Renovable. Eficiencia Energética.

1 INTRODUCTION

The integration and adoption of digital technologies in the electricity sector are promoting profound transformations in the way energy is generated, distributed, and consumed. This revolution stands out especially among homes that seek to be sustainable and environmentally friendly. Technological innovations have not only transformed production, but also the way energy is delivered to consumers and how they use it in their homes. In this scenario, the combination of renewable energy sources, cutting-edge automation systems, and data analysis tools has been essential to develop residential models that are much more efficient. These domestic consumption models allow for a constant and dynamic visualization and adjustment of energy consumption, which enables a more efficient management of available energy resources. This interaction that we are witnessing today is a clear reflection of the growing convergence between technological innovation and sustainability, which, in turn, is closely linked to the incessant search for solutions that minimize harmful effects on the environment. In addition, this guideline also covers energy autonomy, highlighting the urgency of developing alternatives that not only reduce environmental impact, but also increase independence from traditional energy sources. Therefore, it is clear that there is a strong connection between these areas, which are becoming more complementary than ever in today's world.

At the same time, the incessant advancement of artificial intelligence has significantly expanded the possibilities of energy management in residential environments, allowing intelligent systems to be able to analyze and understand energy consumption patterns, predict future demands, and adjust in real time efficiently and effectively. This enables a more efficient and sustainable management of available energy resources. Connected to innovations in energy storage, this strategy enables a more balanced and efficient use of renewable sources, especially because they are intermittent and change throughout the day and year. Thus, it seeks to maximize the use of these sustainable sources, taking into account the conditions and characteristics that can influence their generation. In this way, architectures that fit the definition of smart start to play an important role in the organization of energy flows, contributing decisively to greater efficiency and stability of energy consumption in the residential context.

In view of the panorama exposed above, this work proposes, as a general objective, to analyze how smart architectures based on artificial intelligence can optimize the management and storage of renewable energy in sustainable housing, aiming at greater energy efficiency and home autonomy. The specific objectives are as follows: Understand the fundamentals of smart architectures applied to sustainable housing using renewable energy; Analyze the role of artificial intelligence in managing consumption and optimizing the use of renewable energy in homes; Evaluate renewable energy storage technologies and strategies in smart homes and their impacts on energy efficiency.

As for how to conduct the research, the present study uses a qualitative approach methodology, which is guided by the analytical interpretation of data obtained from several different sources. This approach provides a more detailed and deeper understanding of the phenomenon in question, allowing a broader interpretation of the data collected. This specific approach allows for a more detailed examination of the research object, considering not only the relationships it establishes, but also the contexts and meanings associated with the various technologies under study. Thus, it is possible to achieve a deeper and broader understanding of the topic under discussion. It is possible to elaborate a consistent analysis by gathering theoretical and documentary information, which allows for the articulation of different perspectives on the topic in question. This perspective adds to the understanding of the subject, allowing for a more detailed and complete conversation.

Finally, this study was organized into four sections, so that the topic can be presented in a clear and coherent way. The introduction, which clearly and objectively brings both the contextualization of the topic in question and the objectives that guide the development of this study, is in the first section of the document. Next, the section that deals with the methodology clarifies in detail the various procedures that were adopted and applied during the execution of the research. The third part of the work, which is intended for the theoretical foundation, deals with and discusses the most important concepts, as well as the various approaches that are closely connected to the topic in question. This section is vital for a deeper understanding of the main arguments that support the discussion. Finally, the final considerations serve to clearly and directly summarize the results obtained throughout the research and to indicate possibilities and potential trajectories for future investigations to be carried out, thus contributing to the advancement of the field of study in question.

2 METHODOLOGY

The increased use of smart architectures in homes that value sustainability, especially with regard to artificial intelligence aimed at the management and storage of renewable energy, reflects a profound and continuous change in the design and operation of the energy systems that power homes. This change is not only a technological step, but also a new way of seeking more conscious and efficient energy consumption in homes. It is precisely in this aspect that it becomes even more crucial, especially in the current context, where there is an urgent need to increase energy efficiency and reduce dependence on conventional energy sources. In addition, this strategy also facilitates the increase of autonomy in relation to energy consumption in homes. In view of this, investigating the relationship between digital technologies, storage systems, and renewable energy sources enables a deeper and more organized understanding of the various paths that are being adopted for homes to become more adaptable and energetically balanced. Therefore, it is possible to see how these interactions favor a more sustainable development of the environments in which we live.

Therefore, the methodology that was selected and is being applied in this context is classified as qualitative. This is because this type of approach focuses especially on the interpretation and detailed analysis of data that are collected from various theoretical and documentary sources. This approach seeks to understand, in depth, the particularities and subtleties of the data, enabling a richer and more detailed perspective on the object of analysis. Pereira et al. (2018) state that, when it comes to phenomena that have greater complexity, qualitative research is more effective for understanding, as it considers not only the meanings, but also the relationships and contexts in which these phenomena are inserted. This allows for more detailed analyses adapted to the particularities of each case. In addition, Sousa and Santos (2020) highlight that the approach presented is very favorable to the construction of scientific knowledge, as it allows the exploration of multiple dimensions of the phenomena under analysis. This is particularly pertinent in investigations that address technological innovation and the intricate dynamics of energy.

In order for this study to be carried out and move forward, two research methods were used, which are bibliographic review and documentary research. The first, bibliographic review, is a thorough research of the existing literature on the subject; the second, documentary research, refers to the collection and analysis of documents that are pertinent and relevant to the subject in question. Thus, these procedures proved to be essential to support and improve the work carried out. The bibliographic review is fundamental for the organization and systematization of knowledge already produced scientifically, allowing the identification of a variety of concepts, theoretical models, and approaches that have been consolidated and debated in the specialized literature. In this way, it becomes an indispensable resource to understand the state of the art in a specific area of knowledge. As stated by Pereira et al. (2018), this type of survey is essential for the construction of a consistent and coherent theoretical base, as it brings together and carefully analyzes various contributions from different research and studies on the subject. The literature review found in the work presented here was meticulously elaborated, based on the extensive analysis of a variety of sources, which include not only theses and monographs, but also scientific articles that have been published in academic events, as well as those published in journals dedicated to scientific research. Books that deal with the subject in a specialized way were also taken into account.

Desk research is crucial to help evaluate information from institutional and technical sources, which reveal practical applications and valuable guidance for the energy sector. Therefore, this focus enables a deeper understanding of the rules that govern this essential segment of the economy. Pereira and Oliveira (2024) emphasize the relevance of this procedure, as it allows the examination of documents that record practices, policies, and technological solutions. This analysis also significantly expands the understanding of the object of study. Therefore, several documents that were made available by various companies and organizations in the sector were analyzed, such as BYD Company Limited, in relation to the year 2024, in addition to Contemporary Amperex Technology Co. These documents were indispensable for the analysis that was proposed. Limited produced, in 2024, documents and reports that, like those of the International Energy Agency, published in 2023, and those of the Tesla company, also from 2024, as well as Reddy's work, which is scheduled for publication in 2025, offer important information and guidelines on the various types of energy storage systems and their numerous practical applications in the contemporary world.

The joint adoption of the literature review and documentary research proved to be adequate to the purpose of the investigation, as it allowed the articulation of theoretical foundations with practical evidence from the energy sector. The articulation between these two research procedures proved to be decisive for a broader understanding of the complexities and particularities of this field of research, allowing the construction of knowledge that encompasses both established concepts and observable realities. The method used here was what is usually called mixed research, which in this case allowed for a more consistent and integrated analysis of the subject, because it combined academic reflection, which provides the theoretical basis, with data and information from real situations and contexts of practical application. This union between theory and practice is essential for a deeper understanding of the topic in question. With this, it became possible to develop a much broader understanding of the application of artificial intelligence and storage systems in the context of sustainable homes. This gave a superior rigor and coherence to the research carried out.

3 THEORETICAL FOUNDATION

The theoretical foundation was structured in order to contemplate, in an articulated way, the main axes that support the analysis proposed in this research. To this end, it was organized into three complementary topics, which dialogue with each other and allow a progressive understanding of the investigated phenomenon. The first topic, 3.1 Smart architectures and integration of renewable energies in residential environments, addresses the technological foundations and integration models between digital systems and renewable sources. Next, topic 3.2 Artificial intelligence applied to residential energy management examines the role of algorithms in monitoring, predicting and adjusting energy consumption in real time. Finally, topic 3.3 Energy storage systems and efficiency in sustainable housing discusses storage technologies and their implications for energy autonomy and stability. This organization favors a chained approach, in which concepts are presented progressively, allowing greater coherence in the analysis of the object of study.

3.1 SMART ARCHITECTURES AND INTEGRATION OF RENEWABLE ENERGIES IN RESIDENTIAL ENVIRONMENTS

The interconnection between digital technologies, distributed energy systems, and home automation is what distinguishes the debate on smart architectures aimed at sustainable homes. From this point on, the integration of renewable sources, notably photovoltaic systems, is managed by computational platforms that supervise, examine, and adjust energy consumption in real time. As Silva and Dias (2025) point out, the incorporation of web technologies in energy management amplifies control and enables the development of more effective models, since it favors continuous communication between devices, users, and management systems.

The literature indicates that energy management systems in smart homes have evolved from autonomous systems to user-oriented systems, in which artificial intelligence is essential for the automation of deliberations. As reported by Wang et al. (2021), such systems are developed to apprehend consumption patterns, anticipate demands, and adjust energy use based on environmental and behavioral variables. Such a strategy benefits management that adjusts more efficiently to the concrete demands of residents, reducing waste and optimizing the overall energy performance of the building.

The incorporation of Internet of Things (IoT) devices in homes has enabled the formation of smart energy centers, in which multiple sources and storage systems operate in coordination. According to El-Afifi et al. (2024), such hubs work with sensory devices, algorithms, and digital platforms to optimize, in real time, energy flows, always aiming at a balance between generation, consumption, and storage. As Yun, Nam, and Baek (2018) indicate, integrated automation also favors increased autonomy in relation to energy, as it enables agile responses to changes in the availability of renewable sources.

In this sense, Table 1 is presented, which systematizes the main components and models of technological integration in intelligent architectures aimed at sustainable housing.

Table 1

Components and integration models in smart architectures for sustainable housing

Element	Description	Role in energy management
Smart sensors	Devices that monitor variables such as temperature, luminosity, and consumption	Real-time data collection to support decision-making
Internet of Things (IoT)	Network of connected devices that communicate with each other	Integration and automation of residential systems
Photovoltaic systems	Solar panels for electricity generation	Renewable energy production at home
Storage Systems	Batteries and energy storage technologies	Storage of surpluses for later use
Artificial Intelligence	Data learning and analysis algorithms	Consumption optimization and demand forecasting
Smart energy hubs	Integrative platforms from multiple sources and devices	Coordination of energy flows
Home Automation Systems	Automated Equipment Control Technologies	Dynamic adjustment of energy consumption

Source: Adapted from Silva and Dias (2025); El-Afifi et al. (2024); Wang et al. (2021); Yun, Nam and Baek (2018).

The buildings mentioned are completely aligned with the principles of bioclimatic design, which uses the climatic and environmental characteristics of the site to increase the energy efficiency of buildings. Thus, it seeks to promote a more conscious and rational use of available natural resources, in favor of a more sustainable construction that respects the environment. According to Oliveira et al. (2021), there are a number of strategies that can be employed to reduce the need for energy consumption in buildings. Among these strategies are natural ventilation, which ensures air circulation; solar orientation, which makes the most of sunlight during the day; and the choice of suitable materials, which are selected according to their thermal properties and energy efficiency. Technology reduces the demand for energy and works together with intelligent systems that work in harmony to maximize energy efficiency. In this way, the link between passive solutions and automatic systems significantly increases the efficiency of sustainable homes, promoting a harmonious integration between what is constructive and what is technological, in a synergistic and cohesive way.

Thus, the idealization of the so-called house of the future needs to be seen in an integrated way, aligning innovation, sustainability, and quality of life. It is, therefore, essential that these three aspects are intertwined in a synergistic way in the planning and implementation of housing developments that aim not only at well-being, but also at sustainability and innovation. According to Vassão et al. (2024), digital technology in the construction industry profoundly transforms the way internal spaces of homes are planned, structured, and experienced by their inhabitants. This concept brings homes that, in addition to adaptability, take particular care with the rhythms and needs of their residents, creating a housing experience that connects all the time to technology. In this way, the so-called smart architectures have been designed to integrate energy efficiency, home automation, and effective management of the resources consumed, creating a new housing standard that better adapts to current requirements. This type of planning aims not only to save energy, but also to create a more sustainable and efficient space for its residents, in line with the needs and challenges of contemporary life.

3.2 ARTIFICIAL INTELLIGENCE APPLIED TO RESIDENTIAL ENERGY MANAGEMENT

The adoption of artificial intelligence in household energy management has proven to be an efficient approach to monitoring and regulating energy use in homes. In Brazil, Sousa and Soares (2025) indicate that the use of intelligent systems provides a more effective management of the energy matrix, by integrating real-time data and simplifying automated decision-making. This is a paradigm shift, moving from a reactive approach to predictive management, in which consumption is monitored in real time and adjusted to the conditions of use, as well as the availability of energy resources.

In this context, machine learning algorithms play a significant role in making it possible to identify consumption patterns and predict future energy needs. As Costa (2024) points out, artificial intelligence, when incorporated into electrical systems, provides more effective management, allowing the anticipation of demand peaks and the redistribution of loads more efficiently. Such aptitude in sustainable homes provides a more effective use of renewable sources, especially when combined with storage systems that require meticulous planning to improve their performance.

The integration of artificial intelligence with Internet of Things devices amplifies the possibilities of energy management in an automated way. As Ulla et al. (2025) point out, alternatives based on Green IoT employ intelligent algorithms to coordinate appliances in a home, promoting energy savings and offering more efficient control over consumption. Similarly, Nikpour et al. (2024) indicate that systems based on the Internet of Things, combined with advanced analytical methodologies, are capable of managing the complexity of systems, adjusting the flow of energy according to several variables. As Santos and Tateoki (2024) point out, such applications enable optimized consumption in real time, harmonizing operational efficiency with sustainability. In view of these contributions, Table 2 is presented, which organizes the main mechanisms of action of artificial intelligence in residential energy management.

Table 2

Applications of artificial intelligence in the management of residential energy consumption

Application	Description	Impact on energy management
Real-time monitoring	Continuous collection of consumption data through sensors and meters	Increased visibility and control of energy use
Demand forecasting	Use of algorithms to anticipate consumption patterns	Efficient planning of energy use and storage
Optimisation of consumption	Automatic adjustment of the operation of home devices	Reduction of waste and better energy use
IoT integration	Communication between networked devices	Intelligent coordination of residential systems
Machine learning	Historical data analysis for continuous improvement	Adaptation of the system to the users' routines
Renewable energy management	Control of the use of sources such as solar and wind	More efficient use of available sources
Smart Home Automation	Automated control of equipment and systems	Rapid responses to consumption variations

Source: Adapted from Sousa and Soares (2025); Costa (2024); Ulla et al. (2025); Nikpour et al. (2024); Santos and Tateoki (2024).

The integration and consolidation of these various technological applications clearly shows a considerable transformation in the way energy is administered and managed within the residential environment. This change reflects a new approach, making evident the evolution of the methods used for the control and efficient use of energy in homes. Artificial intelligence technology offers the ability not only to observe and monitor accurately, but also to interpret and analyze data constantly over time. This results in automatic adjustments that are implemented in the systems, making it possible to reduce waste and, at the same time, promoting a significant improvement in the overall performance of energy-oriented systems. This procedure plays a significant role in the creation of homes that are more autonomous, in which the management of resource consumption is carried out in an integrated manner, in addition to being in accordance with the real conditions of use. In this way, a new housing standard is promoted that prioritizes efficiency and adaptation to the daily lives of its users (Sousa; Soares, 2025).

In summary, the use of artificial intelligence in energy management in homes indicates significant progress in the search for greater efficiency, as well as a more rational and conscious approach to energy consumption. This innovation has shown promise, as it enables the optimization of energy use, minimizing waste and contributing to more sustainable and responsible consumption. Through the efficient combination of monitoring, forecasting, and automation, these technological innovations provide support that enables a more equitable and harmonious use of renewable energy sources. This support is essential, as it contributes to strengthening the energy autonomy of homes, thus ensuring greater independence with regard to energy consumption. In this scenario, the convergence between intelligent algorithms and technological infrastructure redefines the dynamics of residential consumption, establishing more solid foundations for sustainability in the energy sector (Costa, 2024).

3.3 ENERGY STORAGE SYSTEMS AND EFFICIENCY IN SUSTAINABLE HOUSING

Energy storage systems occupy a central position in the consolidation of sustainable housing, especially when integrated with intermittent renewable sources. Vian et al. (2021) explain that these technologies allow balancing the relationship between generation and consumption, by storing energy surpluses for later use. This mechanism reduces dependence on the conventional electricity grid and contributes to greater stability in energy supply in residential environments.

In the context of distribution networks with high penetration of renewable sources, Almeida (2024) observes that the performance of storage systems is directly associated with the ability to respond to variations in energy generation. In smart homes, this characteristic translates into the possibility of maintaining adequate levels of supply even in periods of low generation, such as on cloudy days in the case of solar energy. Thus, storage acts as an element of energy compensation and balance.

The efficient allocation of these systems is also a relevant factor for the overall performance of networks and consumer units. Morais Filho (2020) highlights that the strategic insertion of storage devices in distribution networks allows for improved operational indicators and reduced losses. On a residential scale, this logic applies to the integration between batteries and distributed generation systems, favoring the more efficient use of locally produced energy.

In addition, storage systems play an important role in supporting the energy transition and sustainability. Ramos et al. (2026) argue that these technologies make it possible to expand the use of clean sources by mitigating problems associated with intermittency. In sustainable housing, this function is reflected in the expansion of energy autonomy, since the user becomes less dependent on external sources and can better manage their consumption.

In the technological field, different solutions have been developed by companies specializing in the sector. BYD Company Limited (2024) presents high-capacity battery-based storage systems, aimed at both residential and commercial applications. These solutions seek to meet the demand for reliability and efficiency by integrating with photovoltaic systems and energy management platforms.

Similarly, Contemporary Amperex Technology Co. Limited (CATL) (2024) invests in the development of advanced storage technologies, with a focus on durability and operational safety. These systems are designed to operate in an integrated manner with smart grids, allowing greater flexibility in energy management and contributing to the balance between supply and demand in connected environments.

The International Energy Agency (2023) points out that the advancement of storage technologies has driven the adoption of more sustainable energy solutions on a global scale. According to the agency, storage plays a strategic role in the integration of renewable energies, by enabling greater control over generation variability. This scenario reinforces the importance of these technologies in the context of smart homes.

In the residential applications segment, Tesla (2024) develops storage systems aimed at integration with solar generation, allowing users to store energy for use at times of greater demand. These solutions contribute to the stability of the home system and expand the ability to manage energy consumption, aligning technology and sustainability.

Finally, the energy storage systems company, Reddy (2025), emphasizes that such systems face challenges related to costs, efficiency, and scalability, but continue to advance as part of the energy transition process. In sustainable housing, the adoption of these technologies represents a consistent strategy to improve energy efficiency and ensure greater autonomy, consolidating a more balanced consumption model adapted to contemporary demands.

4 FINAL CONSIDERATIONS

The focus of smart architectures applied to sustainable housing, especially with regard to the use of artificial intelligence in the management and storage of renewable energies, is within a context of significant technological and energy changes. These innovations have offered a new vision of how energy is produced, distributed, and consumed in the home, allowing a major transformation in the way energy is consumed and managed in the residential sector. The constant and growing integration between the various digital systems, along with the use of renewable sources and the adoption of solutions for energy storage, has been crucial for the creation of housing models that are more efficient and sustainable. In these new housing formats, automation is essential, because, combined with detailed data analysis, it allows for much more precise and conscious control over energy consumption habits. This also ensures a more efficient use of available energy resources, improving the management of energy consumption in each home.

Throughout the research, it was possible to verify that the overall objective was successfully achieved. It was possible to make an in-depth study of how smart architectures, based on artificial intelligence principles, can optimize the management and storage of renewable energy in sustainable homes. In addition to increasing energy efficiency, this optimization also plays a crucial role in increasing autonomy in residential contexts. Similarly, the specific objectives that were proposed were achieved satisfactorily, as an understanding was obtained about the essential concepts that guide smart architectures, which aim to implement sustainable housing with the use of renewable energies. An in-depth analysis of the relevance and role of artificial intelligence in supervising energy consumption and optimizing energy use in contemporary homes was also carried out. A detailed evaluation of the various technologies available was carried out, along with the strategies for the storage of renewable energy in smart homes, considering how these innovations affect energy efficiency in general.

Regarding the topic discussed in item 3.1, which focuses on smart architectures and the integration of renewable energy sources in the domestic environment, the research revealed that the interaction between interconnected devices, photovoltaic solar energy generation systems and energy management platforms enables the formation of environments that dynamically adjust to variations in energy consumption and generation. It was observed that these architectures favor the automation of various processes and increase the capacity for real-time monitoring of operations, culminating in energy management that adapts more efficiently to the operational requirements of the residential system. This adaptability is essential to improve energy consumption and efficiency, as it enables more detailed control and a quick reaction to any changes in day-to-day activities at home.

With regard to sub-item 3.2, which addresses artificial intelligence in the management of energy consumption in homes, it was noted that artificial intelligence algorithms play a crucial role, as they are essential for forecasting energy demand and effectively help in identifying consumption patterns. In addition, these algorithms are essential for automating decision-making, enabling more efficient and intelligent management of energy consumption in homes. The research pointed out that these systems are capable of constantly changing the way energy is used, resulting in more efficient consumption. In addition, this strategy minimizes the losses often associated with improper use of available energy resources. This effect is especially notable when these systems are combined with interconnected devices and home automation systems, as this integration further enhances their effectiveness and the benefits they provide.

In the midst of the analysis of topic 3.3, which deals with energy storage systems and efficiency in sustainable housing, it was observed that the addition of batteries to hybrid systems is crucial to ensure a more stable energy supply. In addition, these systems are essential to considerably increase the autonomy of homes, allowing them to operate more independently and sustainably. Energy storage has proven to be a very significant and efficient solution to face the intermittency of renewable energy sources. This is because this technology allows the energy that has been accumulated in times of low demand to be released when demand increases or when generation is not sufficient. In this way, this practice leads to a notable increase in the balance between the energy available and that which is consumed.

For future research, it is suggested that empirical investigations be conducted to examine in more detail the practical implementation of these technologies in different types of homes. In this sense, it is essential to take into account relevant variables such as the cost, the accessibility of the technologies to the general public, and the performance that these technologies will show during prolonged use. With this, it is intended to achieve results that can enrich the understanding of the effect of these innovations in various home contexts. It is equally pertinent and appropriate to carefully examine how artificial intelligence relates to innovations in data storage systems. Nor can we ignore the regulatory effects and social consequences that may arise from the large-scale adoption of these technologies. This examination would enable a deeper understanding of the feasibility and use of these tools in the current energy scenario.

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